1/12° Pacific HYCOM: The End Of A Long Simulation

E. Joseph Metzger, Harley E. Hurlburt and Alan J. Wallcraft
Naval Research Laboratory, Stennis Space Center, MS

HYCOM NOPP GODAE Meeting
27-29 October 2004
RSMAS, Miami, FL

		Form Approved OMB No. 0704-0188
	Report Documentation Page	*Form Approved* *OMB No. 0704-0188*

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE **OCT 2004**	2. REPORT TYPE	3. DATES COVERED **00-00-2004 to 00-00-2004**
4. TITLE AND SUBTITLE **1/12degree Pacific HYCOM: The End Of A Long Simulation**		5a. CONTRACT NUMBER
		5b. GRANT NUMBER
		5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER
		5e. TASK NUMBER
		5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Research Laboratory,Stennis Space Center,MS,39529**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release; distribution unlimited**

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

| 16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT **Same as Report (SAR)**	18. NUMBER OF PAGES **22**	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**			

1/12° Pacific HYCOM Modeling at NRL

- Initial 1/12° Pacific modeling began in Dec 2001 on the IBM SP at the Maui High Performance Computing Center

- Part of the FY02-FY04 DoD HPC Challenge grant: "Basin-scale prediction with the HYbrid Coordinate Ocean"

- Original proposal called for 46 years of both climatological and interannual forced simulations

- Completed 60 years of integration under Challenge: 17 climatological + 43 interannual

Major 1/12° Pacific HYCOM Experiments

- **Climatological forced:**
  - **HR winds/ECMWF fluxes: 14 years**
  - **ECMWF winds/ECMWF fluxes: 20 years**

- **Interannual forced: 3 or 6 hourly**
  - **ECMWF winds + fluxes: 1979 – 2003**
    - **Highest horizontal/vertical resolution basin-scale simulation run for this long with interannual forcing**
    - **Integrated on ARL IBM SP3**
      - **~1.45E6 Sus (4900 hrs x 297 processors)**
    - **Took 11 calendar months to complete**
    - **Generated 17.3 Tb of output**

  - **FNMOC NOGAPS winds + fluxes: 2001 - 8/2004**
    - **Initial state from this experiment will be used in a simulation with data assimilation**
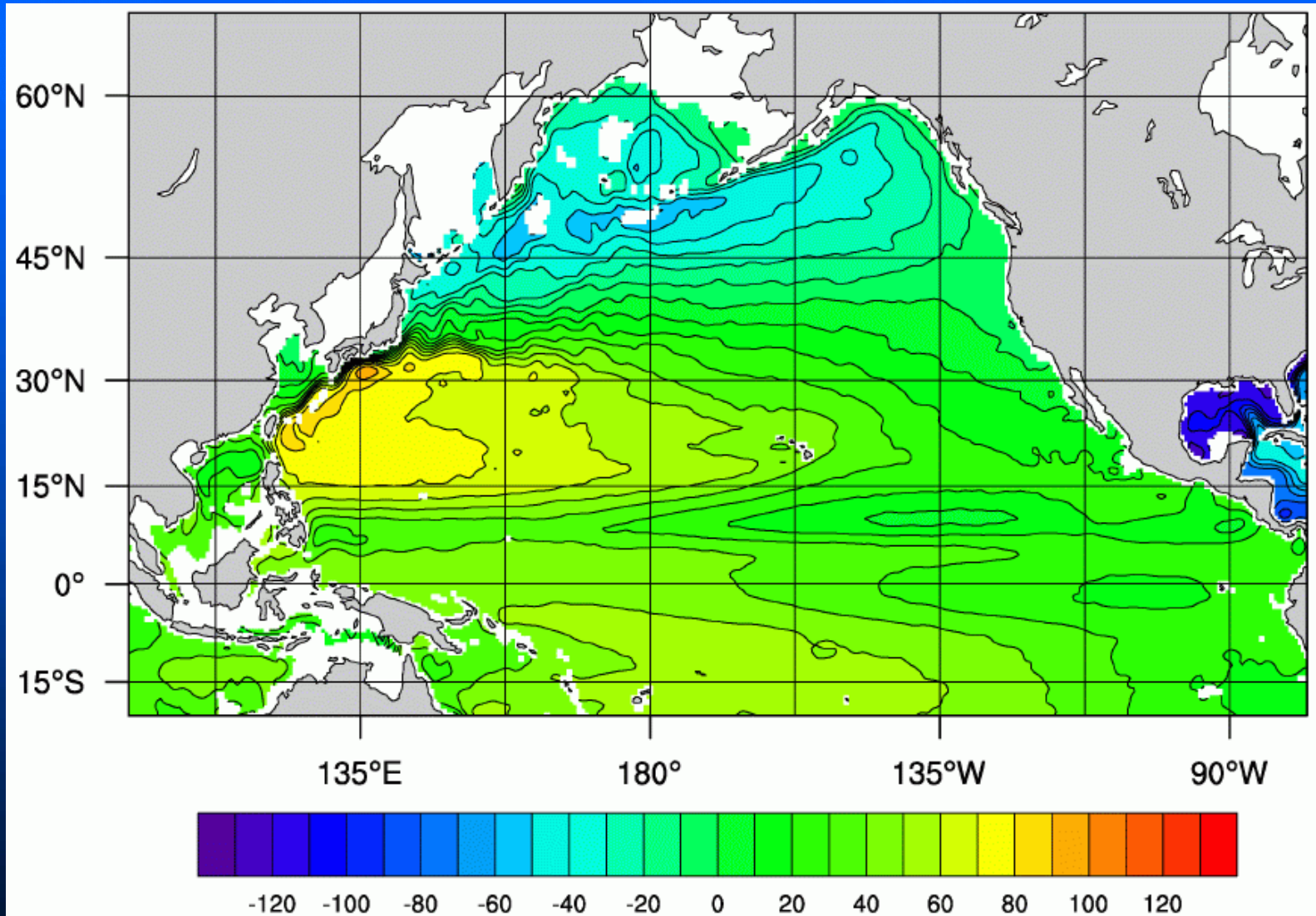
Basin-wide Mean Circulation
HYCOM Mean SSH
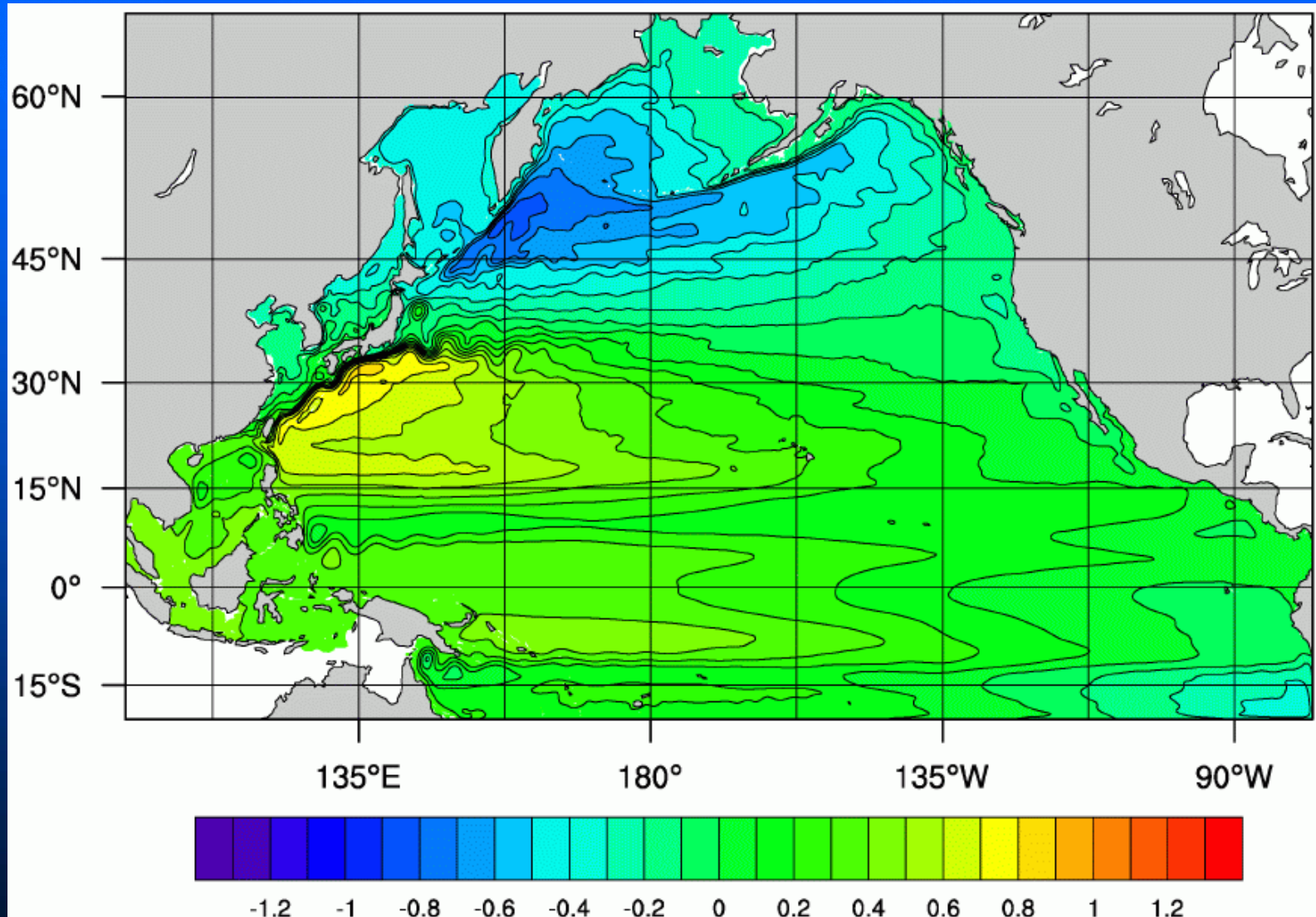
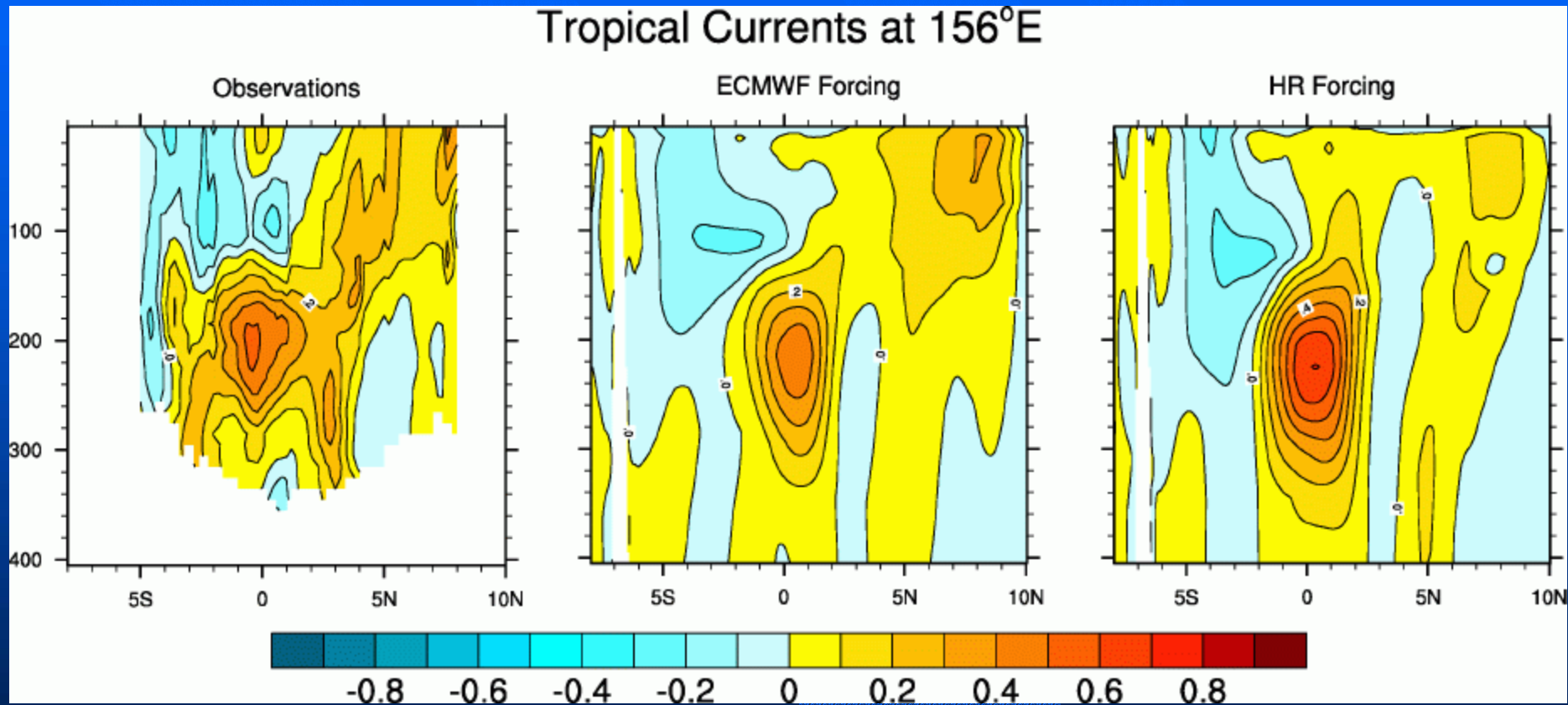**1/12° Pacific HYCOM – ECMWF climatological forcing**

Basin-wide Mean Circulation
1992-2002 Mean SSH

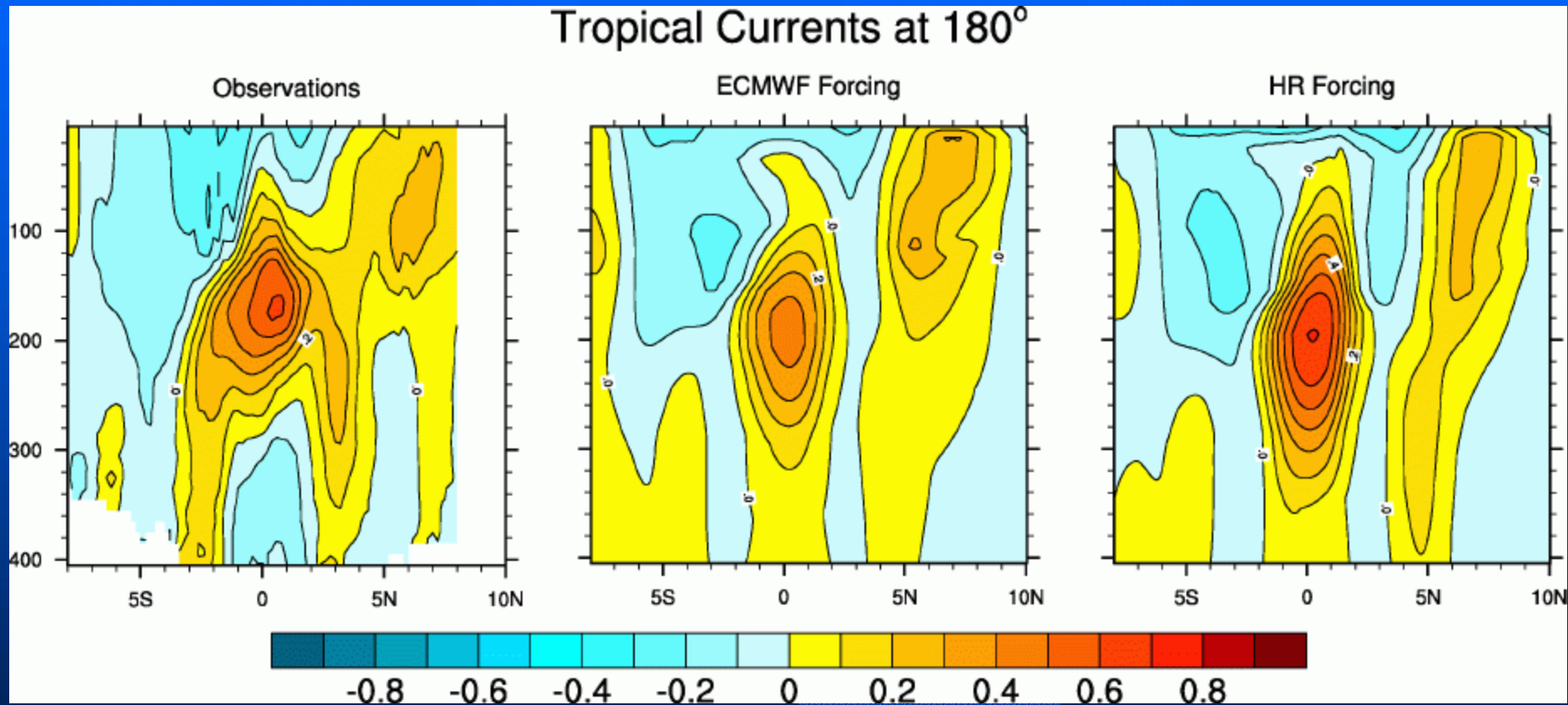**Niiler et al. (2003, GRL) – 40 cm bias removed**

Tropical Current Systems
Zonal velocity across the equator

Tropical Currents at 156°E

Observations from Johnson et al. (2002, Prog. Oceanogr.) HYCOM with ECMWF or HR climatological forcing

Tropical Current Systems
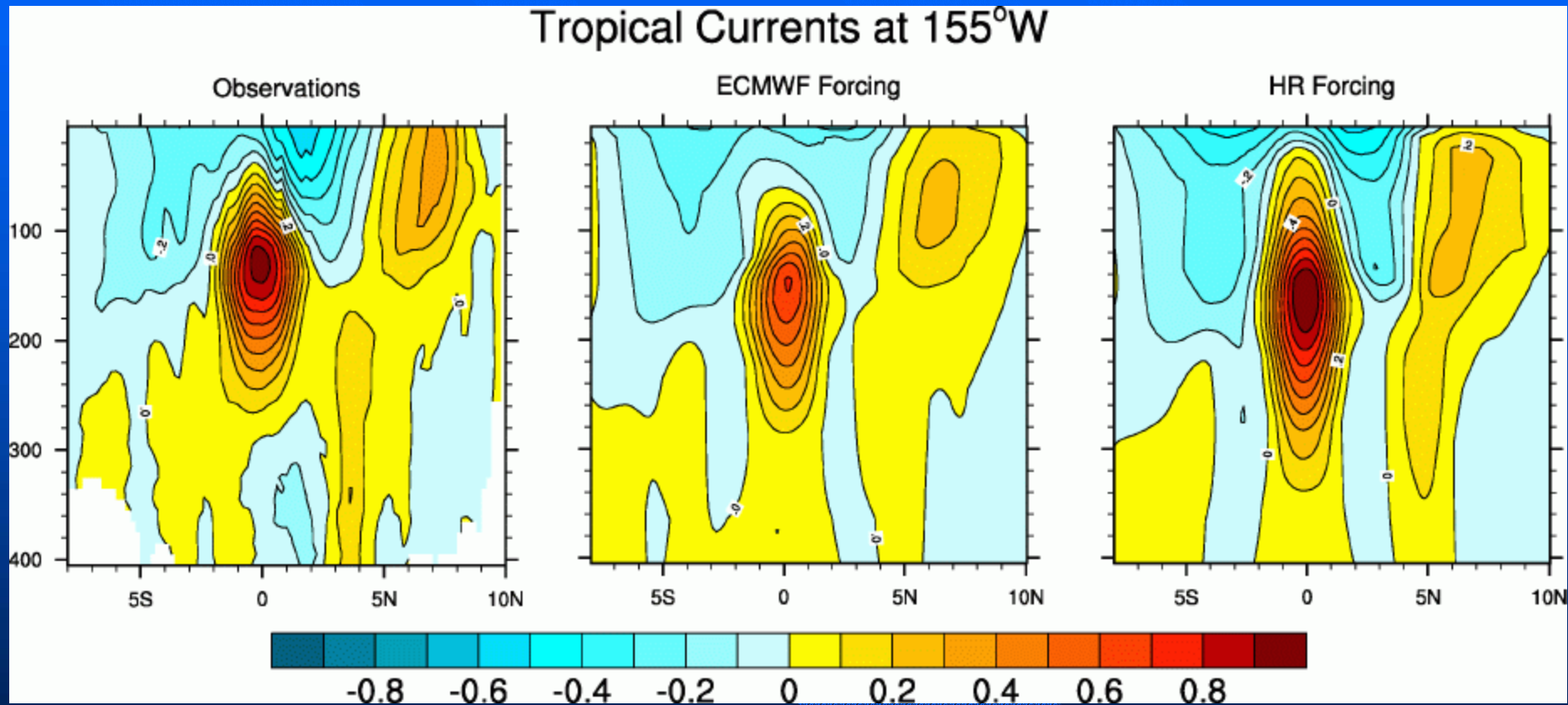## Zonal velocity across the equator

Tropical Currents at 180°

Observations from Johnson et al. (2002, Prog. Oceanogr.)
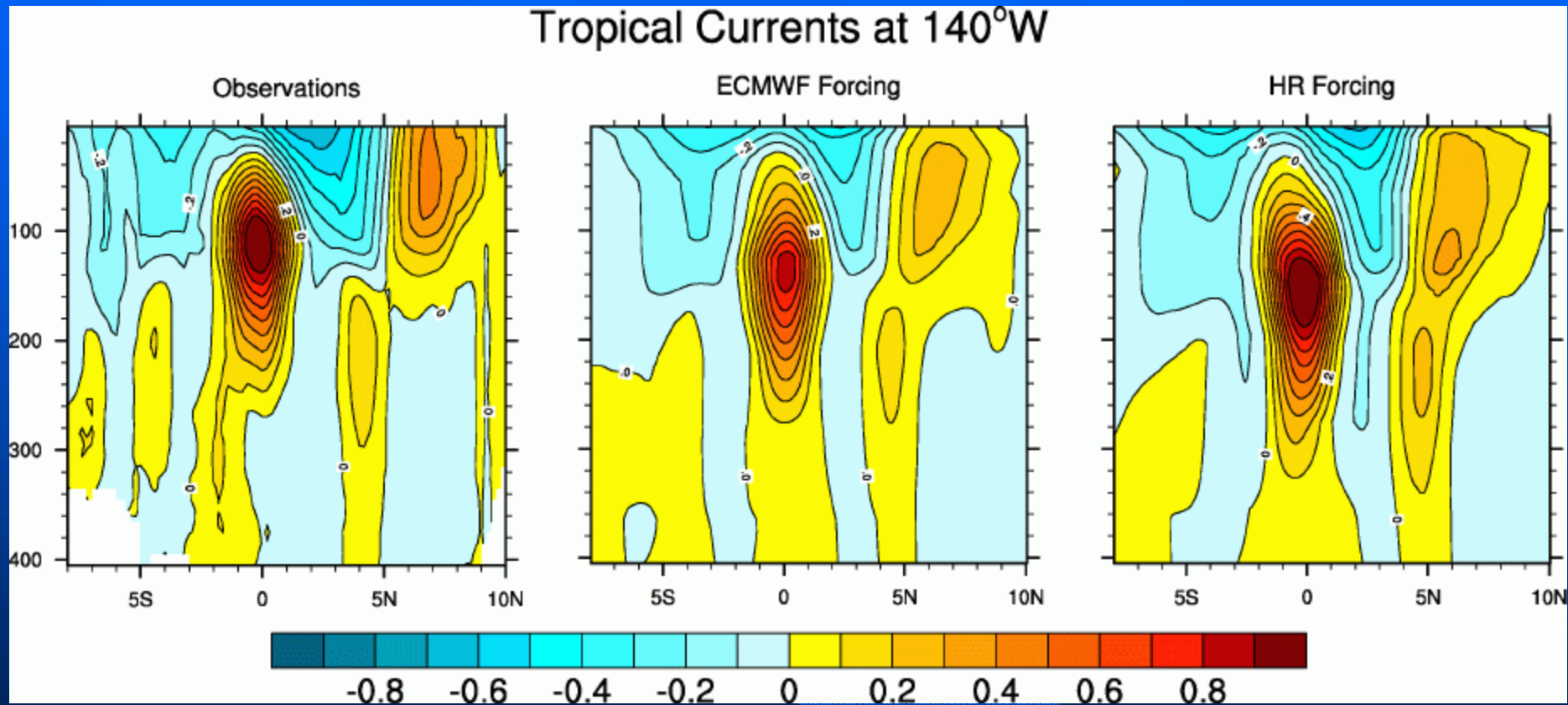**HYCOM with ECMWF or HR climatological forcing**

Tropical Current Systems
Zonal velocity across the equator

Tropical Currents at 155°W

Observations from Johnson et al. (2002, Prog. Oceanogr.) HYCOM with ECMWF or HR climatological forcing
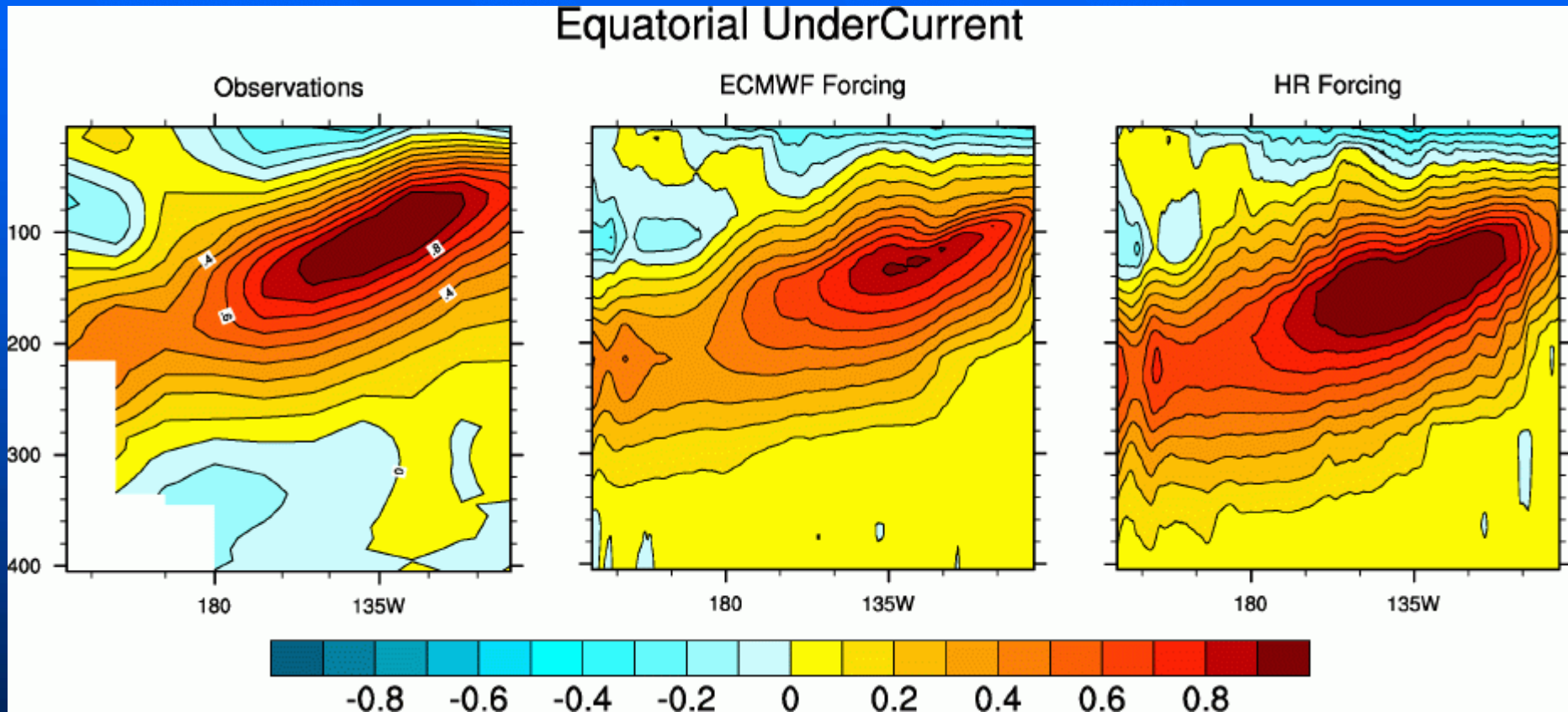
Tropical Current Systems
Zonal velocity across the equator
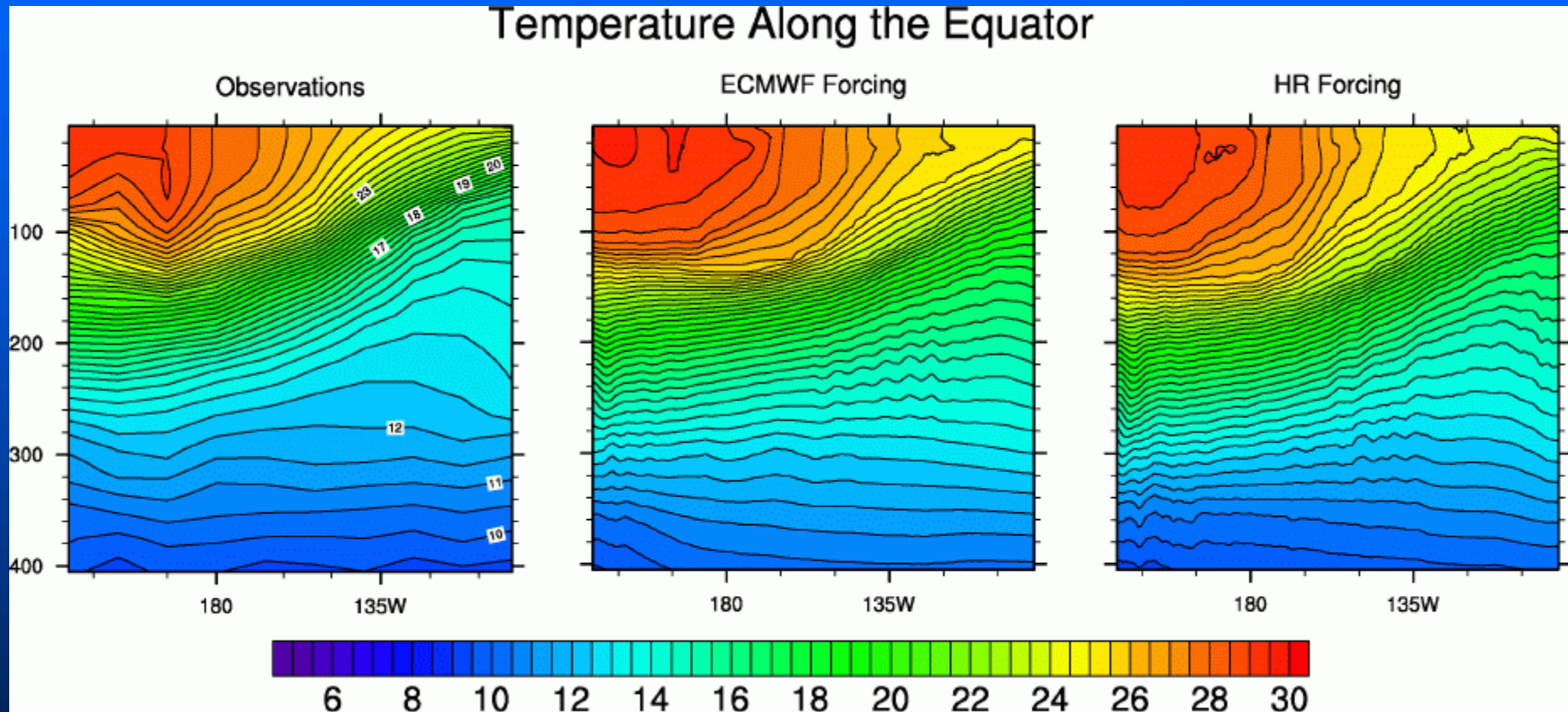

Tropical Currents at 140°W

Observations from Johnson et al. (2002, Prog. Oceanogr.)
HYCOM with ECMWF or HR climatological forcing

Equatorial Currents
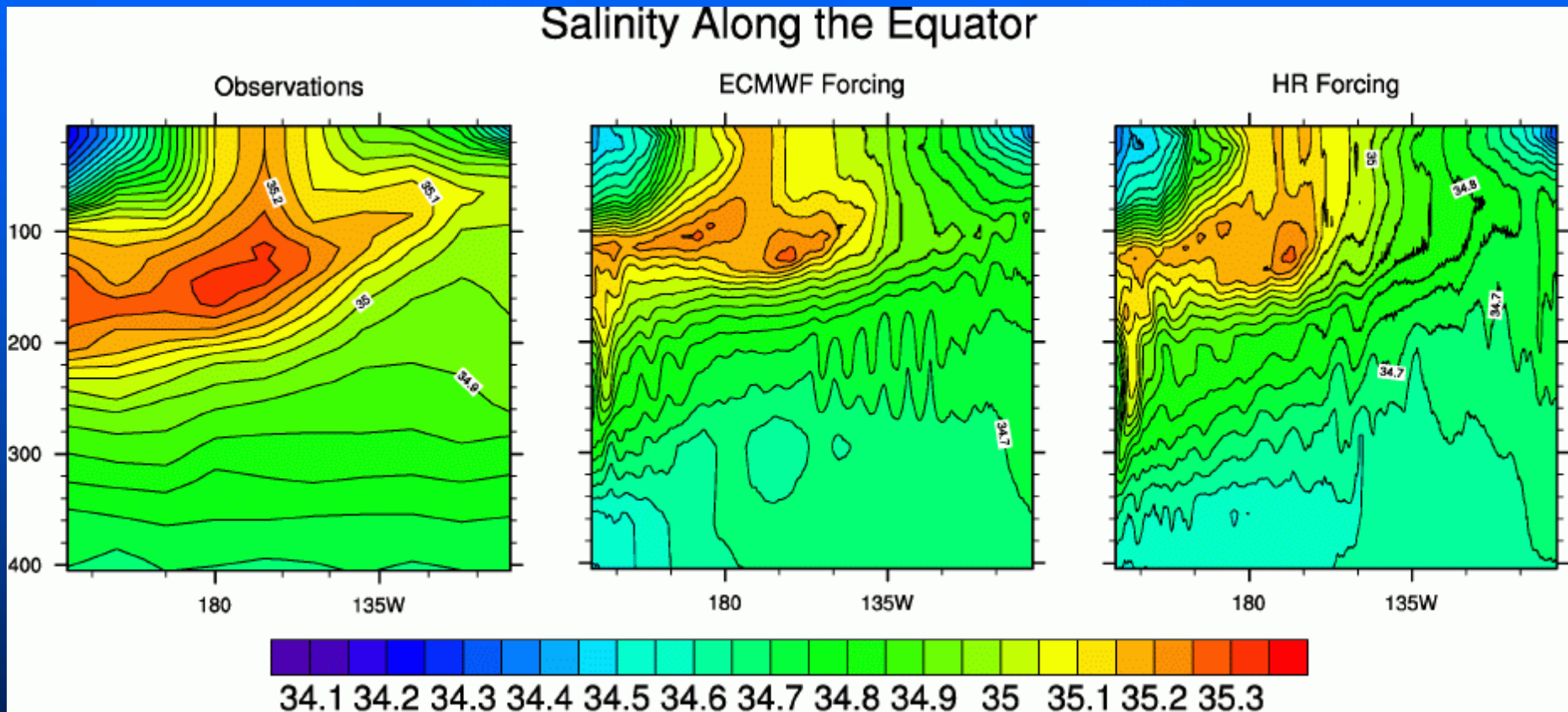## Zonal velocity along the equator

Equatorial UnderCurrent

Observations from Johnson et al. (2002, Prog. Oceanogr.)
HYCOM with ECMWF or HR climatological forcing

Equatorial Temperature

Temperature Along the Equator

Observations from Johnson et al. (2002, Prog. Oceanogr.)
HYCOM with ECMWF or HR climatological forcing

Equatorial Salinity
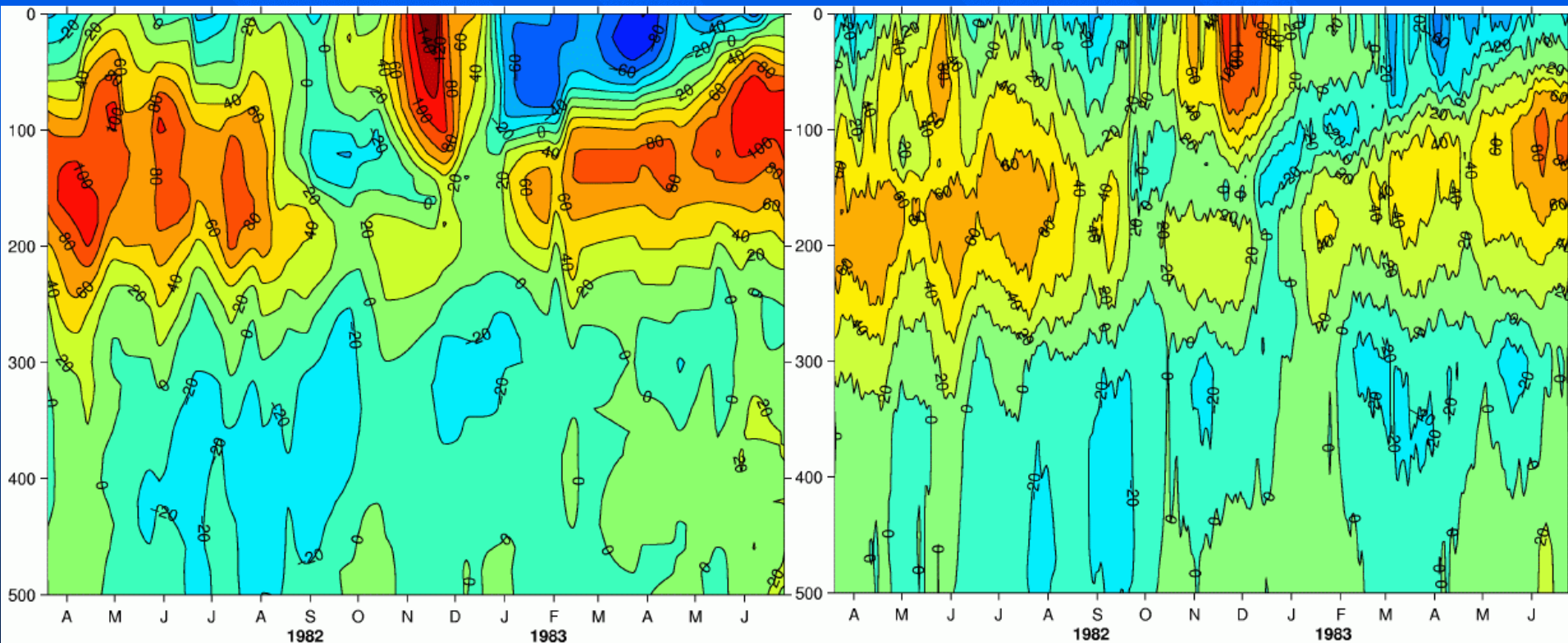

Salinity Along the Equator

Observations from Johnson et al. (2002, Prog. Oceanogr.)
HYCOM with ECMWF or HR climatological forcing

Disappearance of the Equatorial Undercurrent During the 1982-83 El Niño
Zonal velocity on the Equator at 159°W

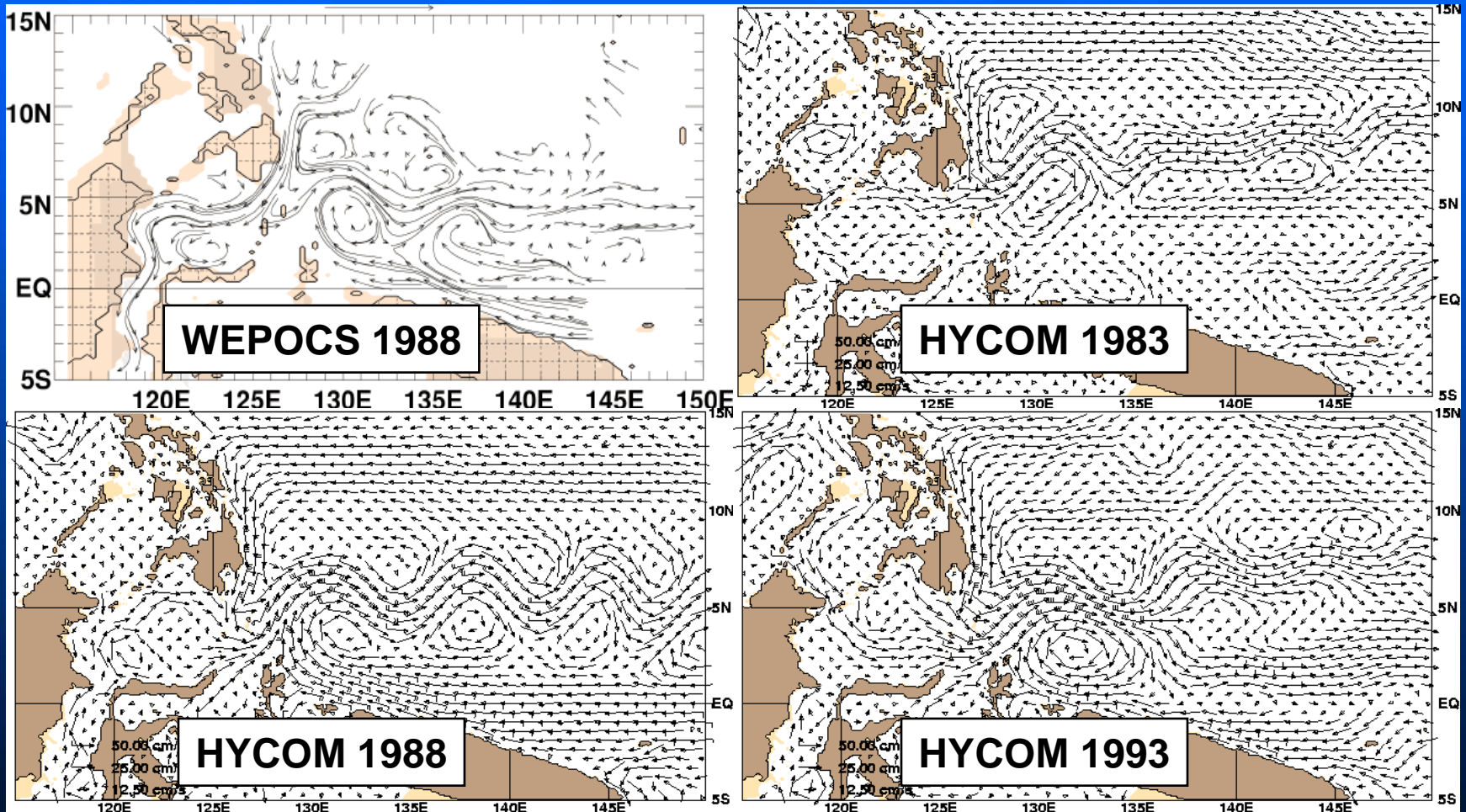Adapted from Firing at al. (1983)   1/12° Pacific HYCOM

Yellow/red = eastward flow, blue = westward flow
HYCOM forced with interannual ECMWF winds and heat fluxes
No oceanic data assimilation

Currents in the Western Equatorial Pacific
WEPOCS III observations vs. HYCOM
July-August-September upper ocean currents

WEPOCS 1988

HYCOM 1983

HYCOM 1988

HYCOM 1993

WEPOCS from Lukas et al. (1991, JGR)

Vector Correlation
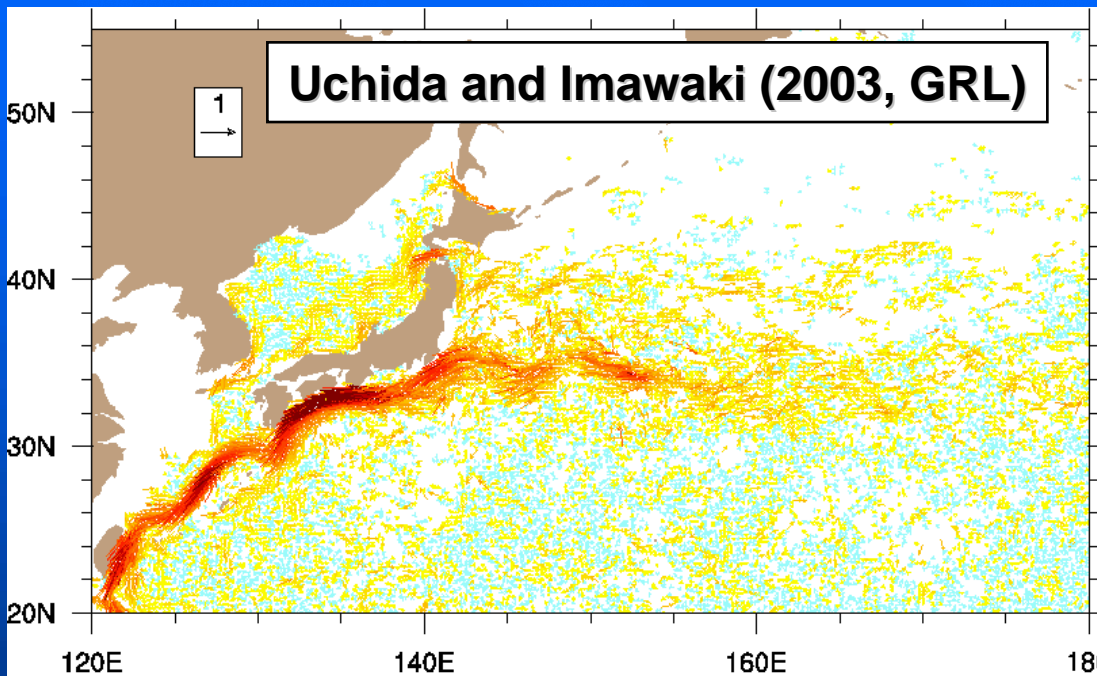## WEPOCS III observations vs. HYCOM

WEPOCS III JAS 1988 mean vs. HYCOM JAS means for individual years

1980	.34	1987	.31
1981	.46	1988	.60
1982	.47	1989	.51
1983	.11	1990	.32
1984	.52	1991	.37
1985	.53	1992	.43
1986	.33	1993	.50

Kuroshio Extension Surface Currents
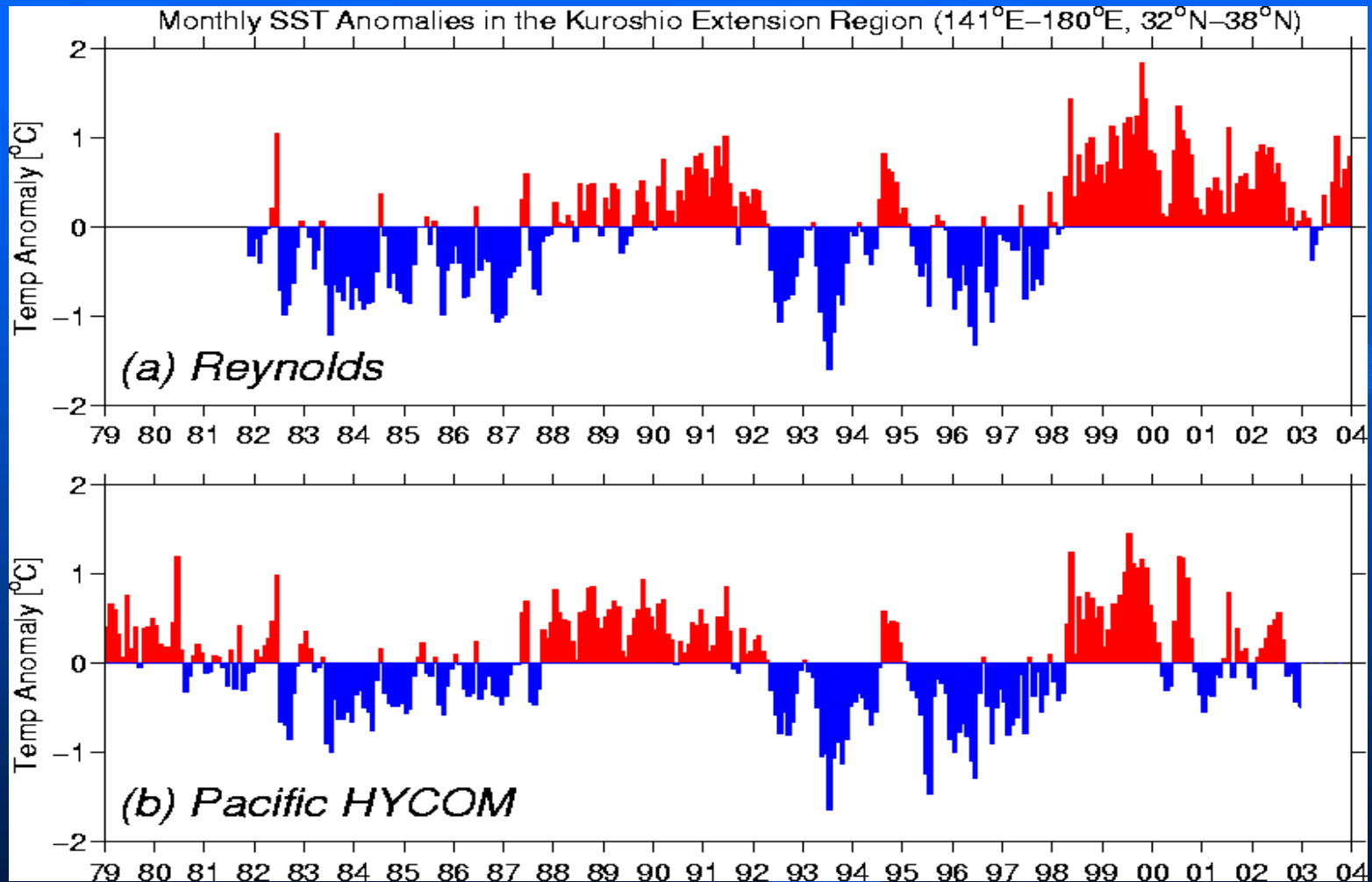## Vectors color-coded by speed

Uchida and Imawaki (2003, GRL)

Jan 1993 – Dec 2000 model mean

Oct 1992 – Dec 2000 mean based on a combination of surface drifter and satellite altimeter data

1/12° Pacific HYCOM
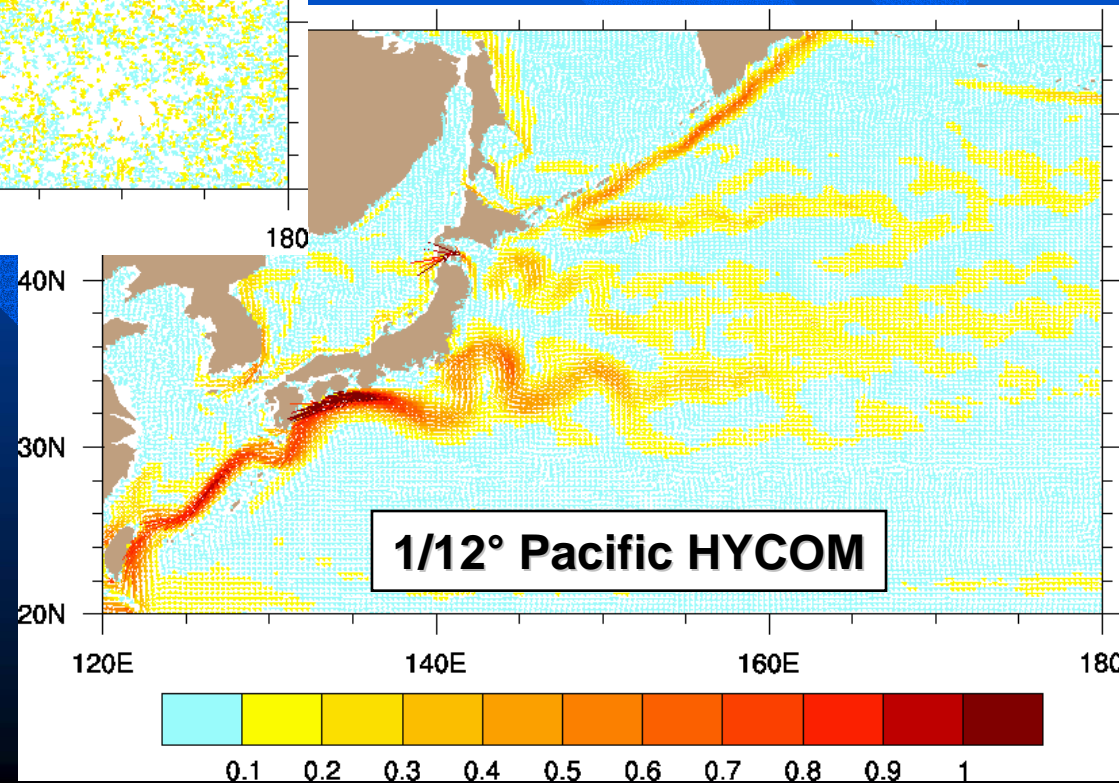
Interdecadal Variability in the Kuroshio Extension
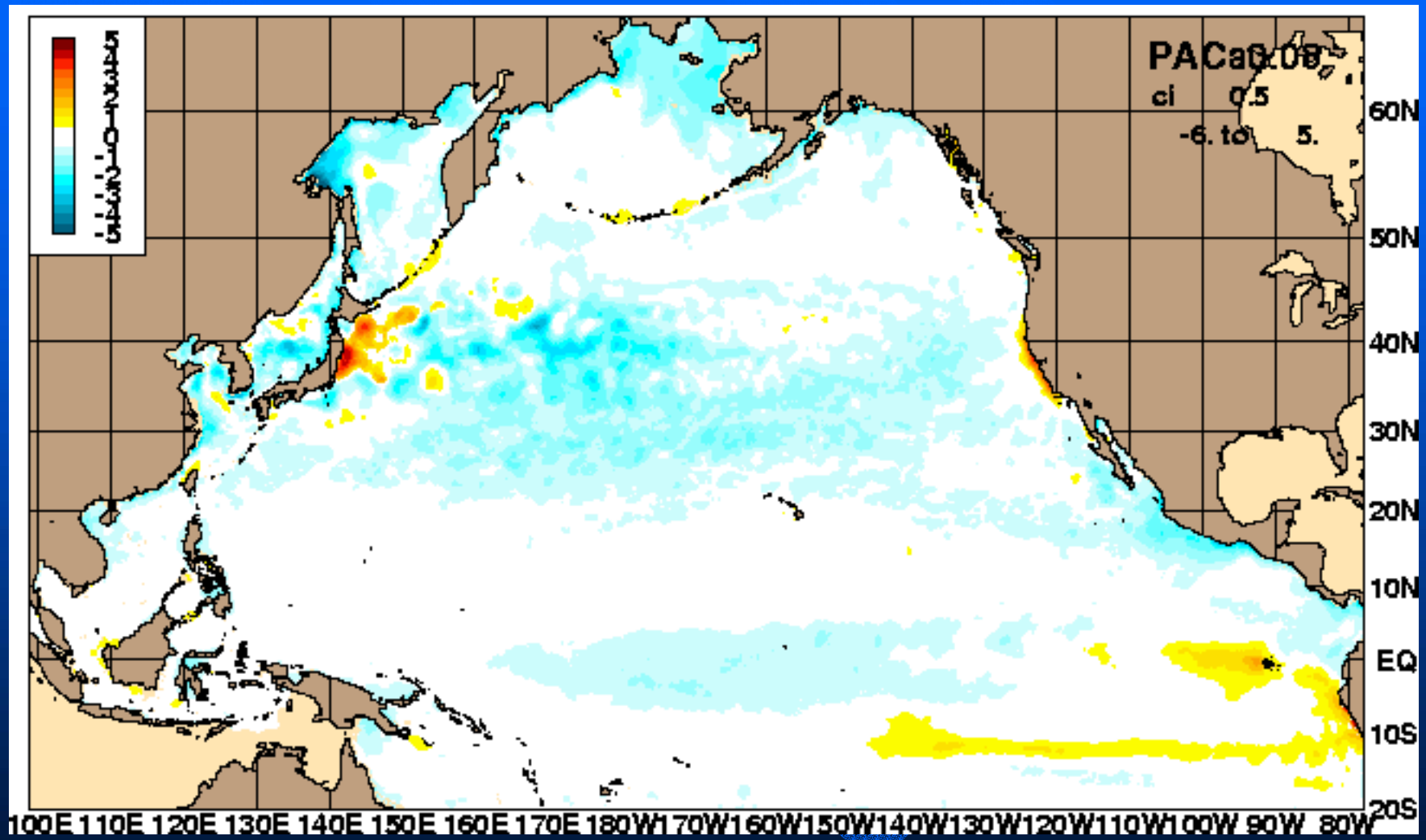## SST anomalies (140°E-180°, 32°-38°N)

Observations from Reynolds and Smith (1994, J. Climate)
Anomaly relative to 1982-2001 monthly climatology
Collaboration with B. Qiu and S. Chen (U. Hawaii)

MODAS SST vs. 1/12° Pacific HYCOM
2003 Mean error

NOGAPS wind/thermal forcing; radiative fluxes corrected to SOC mean
White area ± 0.5°C

Scientific Interest in Pacific HYCOM Output

- **Z. Yu (U. Hawaii)**
  - **project to study equatorial subsurface countercurrents, namely the Tsuchiya Jets**

- **E. Firing and F. Ascani (U. Hawaii)**
  - **project to study sub-thermocline extra-equatorial jets**
  - **symmetric currents extending from about 400 – 1500 m with eastward (westward) flow ~1.5° (~3°) on either side of the equator**

- **J. Kool (RSMAS)**
  - **Developing an agent-based model of intraspecific genetic diversity; using HYCOM output for development and testing**

Scientific Interest in Pacific HYCOM Output

- **L. Rothstein and Y. Luo (U. Rhode Island)**
    - **Looking at the Mixed Water Region in the Kuroshio Extension region**
    - **Analyzing the Kuroshio's impact on the subtropical/subpolar exchange processes**

- **P. Niiler and C. Ohlmann (UCSD)**
    - **ONR funded project to compare HYCOM output with 1990-1999 drifting buoy data in the California Current region**

- **W. Cheng (U. Washington)**
    - **Comparing model pycnocline transport across 9°S/9°N with observations**

Scientific Interest in Pacific HYCOM Output

- **Y. Jia (U. Hawaii - IPRC)**
  - **Developing nested Hawaiian Islands HYCOM**
  - **Using BC's from 1/12° Pacific HYCOM**
  - **Plans call for a high resolution model with data assimilation to predict near-shore sea states, and to provide information for local fisheries, search and rescue operations and hazard management**

- **L. Thompson (U. Washington) and K. Kelly (APL)**
  - **ONR funded project to evaluate 1/12° Pacific HYCOM using satellite and in situ observations**
  - **Long term goal is to improve high resolution ocean models through evaluation and analysis of model subsurface and thermal structure**

Future Plans for Pacific HYCOM

- **Begin a simulation with data assimilation**
  - **NCODA system developed by Jim Cummings**
  - **FNMOC NOGAPS forcing**
  - **Start in 2001 and integrate to near real-time**

- **Transition a near real-time, data-assimilative, semi-operational Pacific HYCOM nowcast/forecast system to NAVOCEANO by the end of FY05**
  - **Will probably run once per week**
  - **1/12° is the target resolution for the global nowcast/forecast system set for transition to NAVOCEANO in FY07**